09:13:07 E R R O R R E P O R T

PATENT NO: 55452072.001 GROUP: T1

OK ISSUE DATE: 02/18/02

PAGE NO: 2 LINE NO: 12 WARNING => TYPEFACE COMMAND [+l/+b/+i] FOLLOWED BY A (+b)

PAGE NO: 0 LINE NO: 0 ERROR => Claim 4 is missing Good

PAGE NO: 25 LINE NO: 568 ERROR => Claim (6) is out of sequence on line 568 OK

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D A C S - E R R O R R E P O R T

PATENT #: 55452072.001 ISSUE DATE: 02/18/02 GROUP: T1

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ERROR, Page #: 2, Line #: 12

INFO, Total Invalid Plus Commands Found: 00001
INFO, Total ALL Text DACS Validation Errors: 00001
INFO, Total ALL Text DACS Validation Warnings: 00000

ENDED TEXT DACS VALIDATION FOR: ***** 55452072.001 *****

--* NEW PATENT *-*-*

Group T1

PATENT # 55452072.001

0001 [pg,1

0002 [sa

0003 A computer enclosure cooling unit adapted to current dimensional <<<< >>>>standards

0004 which is capable of controlled cooling of individual semiconductor <<<< >>>>devices as well as of

0005 the air circulated within the computer housing. The disclosed <<<< >>>>invention utilizes Peltier

0006 devices, a controller unit, both liquid and gaseous heat exchangers, <<<< >>>>and low cost

0007 construction methods to provide a compact, effective computer <<<< >>>>enclosure cooling system

0008 meeting the cooling needs of current high-speed, heat producing <<<< >>>>computer systems and

0009 components.

0010 [ea

0011 [pg,2

0012 [sp [P This is a continuation of U.S. application Ser. No. [b 09/434,<<<<
>>>>873, [l filed Nov. [b 4, 1999, now U.S. Pat. No. +b 6,196,003.

0013 [su [cl BACKGROUND OF THE INVENTION

0014 [p a. Field of the Invention

0015 [p The present invention is related generally to the field of <<<<
>>>>computer enclosure

0016 cooling units. A substantial problem exists in keeping computer <<<<
>>>>enclosures cooled.

0017 Typically a computer enclosure houses numerous semiconductor units, <<<<
>>>>certain motorized

0018 units, and power supplies, all of which tend to be in varying degrees <<<<
>>>>inefficient and

0019 therefore heat producing. Semiconductor units typically have an <<<<
>>>>optimal temperature

0020 operating range at or below room temperature ([b 20 [l degrees <<<<
>>>>Celsius). Most computer

0021 enclosures are air cooled with blowers or fans circulating air from <<<<
>>>>the enclosure into the

0022 ambient of the room within which the computer enclosure is located.

0023 [P More particularly the present invention is related to computer <<<<
>>>>enclosure cooling

0024 units that utilize Peltier devices to enhance heat transfer out of <<<<
>>>>the computer enclosure

0025 into the air circulated into the room ambient. Peltier devices are <<<<
>>>>well known for the

0026 transfer of heat through the device induced by electric current flow. <<<<
>>>>Such devices are

0027 known to be usefully adapted to enhance heat transfer out of <<<<

>>>>individual semiconductor

0028 devices by conduction.

0029 [P Yet more particularly, the present invention is related to <<<<

>>>>computer enclosure

0030 cooling units utilizing Peltier devices that cool not only the <<<<

>>>>individual semiconductor

0031 devices within the computer, but additionally cool the ambient air <<<<

>>>>within the computer

0032 enclosure. As the operating speed of the various semiconductor <<<<

>>>>devices within

0033 computers increases, the inefficiencies and thus the heat generation <<<<

>>>>of the individual

0034 [pg,3

0035 semiconductor devices, and in particular the central processing unit <<<<
>>>>or CPU generates

0036 dramatic quantities of heat. The excess heat generated, in turn, <<<<
>>>>degrades the operation of

0037 the individual semiconductor device further, where by a degenerative <<<<
>>>>spiral of operating

0038 characteristics is encountered limiting the operating speed of the <<<<
>>>>individual

0039 semiconductor unit and thus of the computer.

0040 [p b. Description of the Prior Art

0041 [p Computer enclosure cooling systems comprising fans and blowers are <<<<
>>>>well known

0042 in the art. In fact, several improved blower systems have been <<<<
>>>>developed which create a

0043 partial vacuum in the computer enclosure, or alternatively which <<<<
>>>>provide specific ports

0044 for air flow into the computer enclosure from the room ambient, in <<<<
>>>>order to increase the

0045 transfer of heat out of the computer enclosure into the room ambient. <<<<
>>>>However, all such

0046 prior art blower and/or fan systems encounter a problem, the heat <<<<
>>>>transfer efficiency out

0047 of the enclosure is limited by the temperature differential between <<<<
>>>>the air inside the

0048 computer enclosure and the air in the room ambient.

0049 [P Peltier devices and the use of Peltier devices to transfer heat <<<<
>>>>out of individual

0050 semiconductor materials and devices is well known. Further, the use <<<<

>>>>of Peltier devices in

0051 circuitry to used regulate temperatures of specific semiconductor <<<<
>>>>devices is well known.

0052 However, transfer of heat out of the entirety of the enclosure, <<<<
>>>>rather than just specific

0053 semiconductor devices is need for optimal cooling of the computer <<<<
>>>>enclosure; in that the

0054 density of switches within a specific semiconductor device is a <<<<
>>>>source of excessive

0055 heating and that the density of devices, both electronic and <<<<
>>>>electrical, within the computer

0056 enclosure is yet another source of excessive heating.

0057 [pg,4

0058 [p Additionally well know are air circulation systems to transfer <<<< >>>>heat out of

0059 computer enclosures. Some of these air circulation systems have been <<<< >>>>constructed to

0060 conform to the physical standards set for computer drive bays. <<<< >>>>However, even the

0061 conformance of the air circulation system to the standards set for <<<< >>>>computer drive bays

0062 fails to address the need for focused cooling created by the high <<<< >>>>operating temperatures

0063 of currently available high-density semiconductor devices.

0064 [P Finally, the use of refrigeration systems to cool the entirety of <<<< >>>>the ambient in the

0065 room containing the computer enclosure is well known. The expense of <<<< >>>>this approach is

0066 often prohibitive, as is the physical size and placement of the <<<< >>>>refrigeration system

0067 components.

0068 [pg,5

0069 [cl SUMMARY OF THE INVENTION

0070 [p The instant invention is of a computer enclosure cooling unit that <<<<
>>>>utilizes Peltier

0071 devices to enhance heat transfer out of the computer enclosure and <<<<
>>>>provides both cooling

0072 of the ambient air within the computer enclosure and cooling of <<<<
>>>>selected individual

0073 semiconductor devices within the computer enclosure. The numerous <<<<
>>>>problems noted in

0074 the prior art cooling systems and devices are addressed in the <<<<
>>>>instant invention and the

0075 result is a highly effective, controllable system for cooling a <<<<
>>>>computer enclosure which

0076 may be constructed in conformity with existing standards.

0077 [P Accordingly, it is an object of this invention to provide a <<<<
>>>>computer enclosure

0078 cooling unit which provides high efficiency cooling both of the air <<<<
>>>>circulating generally

0079 within the computer enclosure and of the specific semiconductor <<<<
>>>>devices most

0080 prolifically heat generating.

0081 [P It is a further object of this invention to provide a computer <<<<
>>>>enclosure cooling unit

0082 which uses the controllability of Peltier devices to regulate the <<<<
>>>>temperature and heat

0083 exchange provided by the cooling unit to the computer enclosure and <<<<
>>>>specific

0084 semiconductor devices.

0085 [P It is a yet further object of this invention to provide a computer <<<<
>>>>enclosure cooling

0086 unit which doesn[3 t require increased air flow rates through the <<<<
>>>>computer enclosure in

0087 order to provide adequate cooling of both the enclosure air and <<<<
>>>>specific semiconductor

0088 devices.

0089 [P It is a yet further and final object of this invention to provide <<<<
>>>>a computer

0090 enclosure cooling unit which provides all of the above-described <<<<
>>>>advantages at a low cost

0091 to manufacture, install and operate.

0092 [pg,6

0093 [dr [cl BRIEF DESCRIPTION OF THE DRAWINGS

0094 [p While the novel features of the instant invention are set forth <<<<
>>>>with particularity in

0095 the appended claims, a full and complete understanding of the <<<<
>>>>invention can be had by

0096 referring to the detailed description of the preferred embodiment(s) <<<<
>>>>which are set forth

0097 subsequently, and which are as illustrated in the accompanying <<<<
>>>>drawings, in which:

0098 [P FIG. 1 is a perspective view of the Computer Enclosure Cooling <<<<
>>>>Unit mounted

0099 within a Computer Housing.

0100 [P FIG. 2A is a top plane view of the Computer Enclosure Cooling Unit.

0101 [P FIG. 2B is a lateral plane view of the Computer Enclosure Cooling <<<<
>>>>Unit.

0102 [P FIG. 2C is a front plane view of the Computer Enclosure Cooling Unit

0103 [p FIG. 2D is a rear plane view of the Computer Enclosure Cooling Unit.

0104 [P FIG. 3A is a sectional view of the Computer Enclosure Cooling Unit <<<<
>>>>taken along

0105 the line 3A+13 3A, as shown in FIG. 2A.

0106 [P FIG. 3B is a sectional view of the Computer Enclosure Cooling Unit <<<<
>>>>taken along

0107 the line 3B+13 3B, as shown in FIG. 2A.

0108 [P FIG. 4A is a cutaway perspective view of the Computer Enclosure <<<<
>>>>Cooling Unit

0109 displaying the Enclosure Air Cooling Unit.

0110 [P FIG. 4B is a vertical sectional view of the Computer Enclosure <<<<
>>>>Cooling Unit

displaying the Enclosure Air Cooling Unit.

[P FIG. 5A is cutaway perspective view of the Computer Enclosure <<<< >>>>Cooling Unit with the Enclosure Air Cooling Unit removed to display the Cooling <<<< >>>>Fluid Cooling Unit.

[P FIG. 5B is a vertical sectional view of the Computer Enclosure <<<< >>>>Cooling Unit with the Enclosure Air Cooling Unit removed to display the Cooling Fluid <<<< >>>>Cooling Unit.

0116 [pg,7

0117 [p FIG. 6A is a cutaway perspective view of the Computer Enclosure <<<<
>>>>Cooling Unit

0118 with the Enclosure Air Cooling Unit removed and the Cooling Fluid <<<<
>>>>Cooling Unit

0119 removed, to display the Peltier Heat Exchange Unit.

0120 [P FIG. 6B is a vertical sectional view of the Computer Enclosure <<<<
>>>>Cooling Unit with

0121 the Enclosure Air Cooling Unit removed and the Cooling Fluid Cooling <<<<
>>>>Unit removed, to

0122 display the Peltier Heat Exchange Unit.

0123 [P FIG. 7A is a cutaway perspective view of the Computer Enclosure <<<<
>>>>Cooling Unit

0124 with the Enclosure Air Cooling Unit removed, the Cooling Fluid <<<<
>>>>Cooling Unit removed,

0125 and the Peltier Heat Exchange Unit removed to display the Ambient Air <<<<
>>>>Heat Exchange

0126 Unit.

0127 [P FIG. 7B is a vertical sectional view of the Computer Enclosure <<<<
>>>>Cooling Unit with

0128 the Enclosure Air Cooling Unit removed, the Cooling Fluid Cooling <<<<
>>>>Unit removed, and

0129 the Peltier Heat Exchange Unit removed, to display the Ambient Air <<<<
>>>>Heat Exchange

0130 Unit.

0131 [P FIG. 8A is a perspective view of the Device Heat Exchange Unit <<<<
>>>>mounted on a

0132 CPU.

0133 [P FIG. 8B is a vertical sectional view of the Device Heat Exchange <<<<

>>>>Unit displaying

0134 the Device Cooling Fluid Chamber and fluid flow path.

0135 [P FIG. 8C is a horizontal sectional view of the Device Heat Exchange <<<<

>>>>Unit mounted

0136 on a CPU.

0137 [pg,8

0138 [de [cl DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

0139 [P As seen in FIG. 1, the instant invention is of a computer <<<< >>>>enclosure cooling unit 2.

0140 The instant invention, in use, as depicted in FIG. 1, would normally <<<< >>>>be installed into a

0141 standard [b 5.25 [1 inch drive bay 11 in a computer housing 3. The <<<< >>>>dimensions of the

0142 computer enclosure cooling unit housing 1 are such that the unit may <<<< >>>>be readily mounted

0143 into the space allocated to a standard hard drive unit within a <<<< >>>>computer housing 3.

0144 [P Numerous approaches to a solution of the heat generation problems <<<< >>>>present within

0145 computer housings 3 have been taken by the industry. The instant <<<< >>>>invention takes the

0146 approach of a bifurcated ventilation system, that is, the air <<<< >>>>circulating for heat exchange

0147 to the space outside the computer housing 3 does not mix with the air <<<< >>>>circulating for heat

0148 exchange within the computer housing 3. This is important as the humidity

0149 condensation created by the drying effect when the air internal to <<<< >>>>the computer housing 3

0150 is cooled could destroy the operation of the electronic components <<<< >>>>within the computer

0151 housing 3. Additionally, the instant invention may include cooling of <<<< >>>>individual

0152 electronic components within the computer housing 3, as needed; and <<<< >>>>provides for a

0153 controller unit 7 which may control the temperature of air circulatin<<<<
>>>>g within the computer

0154 housing 3 and the temperature of the cooling fluid or coolant flowing <<<<
>>>>through the cooling

0155 fluid tubing 23 to the device heat exchanger 5, a liquid coolant heat <<<<
>>>>exchanger which

0156 makes a direct, conductive heat exchange with the CPU 25 or other <<<<
>>>>electronic component

0157 selected for individual cooling within the computer housing 3. The <<<<
>>>>CPU 25 is shown in

0158 FIG. 1 to be mounted on a motherboard 9 which normally will provide <<<<
>>>>for mounting of

0159 numerous other electronic and/or electrical components, any one or <<<<
>>>>more of which

0160 electronic and/or electrical components may be the subject of <<<<
>>>>individual cooling by

0161 [pg,9

0162 connection of another set of cooling fluid tubing 23 to another <<<<
>>>>device heat exchanger 5

0163 which is disposed in heat conductive relationship thereto.

0164 [P Also shown in FIG. 1 are the mounting holes 15, which facilitate <<<<
>>>>connection of the

0165 computer enclosure cooling unit housing 1 to brackets within the <<<<
>>>>computer housing 3

0166 which are normally present to secure units inserted into one of the <<<<
>>>>[b 5.25 [1 inch drive bays

0167 11; the ambient air heat exchanger air intake 19 which permits <<<<
>>>>passage of air from the

0168 room ambient into the computer enclosure cooling unit 2; the ambient <<<<
>>>>air heat exchanger

0169 air exhaust 21 which permits passage of air from within the computer <<<<
>>>>enclosure 1 out to

0170 the room ambient; and the ribbon cable 17 which makes the electrical <<<<
>>>>connection

0171 between the computer enclosure cooling unit 2 components and the <<<<
>>>>controller unit 7.

0172 [P FIGS. 2A, 2B, 2C, and 2D are plane views of the computer enclosure <<<<
>>>>cooling unit

0173 housing 1 which show that to the rear of the computer enclosure <<<<
>>>>cooling unit housing 1

0174 are found the enclosure air cooling unit air intake 27 which permits <<<<
>>>>air from within the

0175 computer housing 3 to flow into the computer enclosure cooling unit <<<<
>>>>housing 1; and the

0176 enclosure air cooling unit air exhaust 29 which permits air from <<<<

>>>>within the computer

0177 enclosure cooling unit housing 1 to flow out into the air within the <<<<

>>>>computer housing 3.

0178 [P FIGS. 3A and 3B are sectional views of the computer enclosure <<<<

>>>>cooling unit 2

0179 which show that the instant invention is constructed in essentially <<<<

>>>>four layers, each of

0180 which is herein considered a sub-unit. Working from the top down, the <<<<

>>>>first layer is the

0181 enclosure air cooling unit 26, the second layer is the cooling fluid <<<<

>>>>cooling unit 34, the

0182 third layer is the Peltier heat exchange unit 32, and the fourth, or <<<<

>>>>bottom, layer is the

0183 ambient air heat exchange unit 60.

0184 [pg,10

0185 [p The enclosure air cooling unit 26 is shown in detail in FIGS. 4A <<<<
>>>>and 4B. The

0186 enclosure air cooling unit 26 comprises an enclosure air cooler <<<<
>>>>blower unit 43, a

0187 enclosure air cooling unit air flow baffles 45, an enclosure air <<<<
>>>>cooling unit air intake 27,

0188 and an enclosure air cooling unit air exhaust 29. FIG. 4B depicts the <<<<
>>>>direction of air flow

0189 internal to the enclosure air cooling unit 26 by arrows 47. Also <<<<
>>>>provided by the enclosure

0190 air cooling unit 26 is the upper aperture of a tubular condensate <<<<
>>>>drain 37. The lower

0191 surface of the enclosure air cooling unit 26 is beveled, as indicated <<<<
>>>>by the condensate

0192 drain flow arrows 49 in FIG. 4B, in the preferred embodiment to cause <<<<
>>>>drainage of

0193 condensate from the cooled air within the enclosure air cooling unit <<<<
>>>>26, into the

0194 condensate drain 37, through the cooling fluid cooling unit 34 and <<<<
>>>>the Peltier heat

0195 exchange unit 32, to be discharged into the ambient air heat <<<<
>>>>exchanger 60 where the

0196 condensate is evaporated into the heated air and discharged into the <<<<
>>>>ambient of the room

0197 containing the computer housing 3.

0198 [P FIGS. 5A and 5B are two views of the cooling fluid cooling unit 34 <<<<
>>>>of the

0199 preferred embodiment of the instant invention. The cooling fluid <<<<

>>>>cooling unit 34

0200 comprises a cooling fluid chamber 35, comprising the space between <<<<
>>>>the enclosure air

0201 cooling unit 26 and the Peltier heat exchange unit 32 that is within <<<<
>>>>the computer

0202 enclosure cooling unit housing 1, containing cooling fluid tubing 23 <<<<
>>>>which is coiled

0203 within. The tubular cooling fluid chamber 35 of the preferred <<<<
>>>>embodiment is in heat

0204 conductive contact with the cold side of the Peltier devices 33 <<<<
>>>>contained in the Peltier

0205 heat exchange unit 32 as shown in FIGS. 6A and 6B; and further in <<<<
>>>>heat conductive

0206 contact with the lower surface of the enclosure air cooling unit 26. <<<<
>>>>The cooling fluid

0207 cooling unit 34 provides a pump 31 to circulate the cooling fluid <<<<
>>>>within the cooling fluid

0208 [pg,11

0209 tubing 23. Construction of the preferred embodiment provided a ledge <<<< >>>>51 upon which

0210 the pump 31 was mounted within the cooling fluid cooling unit 34.

0211 [P FIGS. 6A and 6B are two views of the Peltier plate 30 of the preferred

0212 embodiment. The Peltier plate 30 comprises a plurality of Peltier <<<< >>>>devices 33 in electrical

0213 communication with the controller unit 7 through the ribbon cable 17. <<<< >>>>The lower surface

0214 of the Peltier plate 30 is comprised of heat conductive material, <<<< >>>>metal in the preferred

0215 embodiment, and such lower surface is in heat conductive contact with <<<< >>>>the hot side of the

0216 Peltier devices 33.

0217 [P FIGS. 7A and 7B are two views of the ambient air heat exchanger <<<< >>>>60. The ambient

0218 air heat exchanger 60 provides, in the preferred embodiment, two <<<< >>>>ambient air heat

0219 exchanger blower units 61, ambient air heat exchanger internal walls <<<< >>>>64, two ambient air

0220 heat exchanger air intakes 19, and two ambient air heat exchanger air <<<< >>>>exhausts 21. In the

0221 preferred embodiment, spacing between the ambient air heat exchanger <<<< >>>>internal walls 64

0222 provides ambient air heat exchanger internal air flow chambers 39, <<<< >>>>and air flow,

0223 indicated by ambient air heat exchanger air flow arrows 59, is <<<< >>>>continuous between the

0224 ambient air heat exchanger internal air flow chambers 39 by passing <<<<

>>>>through apertures 65

0225 in the ambient air heat exchanger internal walls 64. All materials in <<<<

>>>>the ambient air heat

0226 exchanger 60 are, in the preferred embodiment, comprised of heat <<<<

>>>>conductive materials,

0227 arranged in a maze, and facilitate the transfer of heat from the hot <<<<

>>>>side of the Peltier

0228 devices 33 into the air flow which discharges out of the ambient air <<<<

>>>>heat exchanger air

0229 exhausts 21 into the room ambient.

0230 [P FIGS. 8A, 8B and 8C are of the device heat exchanger 5 which, in <<<<

>>>>the preferred

0231 embodiment is mounted on a CPU 25, although the particular semiconduc<<<<

>>>>tor device upon

0232 [pg,12

0233 which the device heat exchanger 5 is mounted may change with the <<<<
>>>>needs of the

0234 particular computer being cooled. Additionally, there may be a <<<<
>>>>plurality of device heat

0235 exchangers 5 with each such heat exchanger being mounted on a <<<<
>>>>separate semiconductor

0236 device in a situation where multiple semiconductor devices within a <<<<
>>>>particular computer

0237 housing 3 require individual cooling. Finally, it is contemplated <<<<
>>>>that in another preferred

0238 embodiment, the device heat exchanger 5 may be integrally a part of <<<<
>>>>the semiconductor

0239 device such that the semiconductor packaging includes a device heat <<<<
>>>>exchanger 5 and

0240 fittings for attachment of cooling fluid tubing 23.

0241 [P As seen in FIG. 8A, the cooling fluid flow within the cooling <<<<
>>>>fluid tubing 23 is in

0242 fluid communication with the interior of the device heat exchanger 5. <<<<
>>>>Such

0243 communication may be attained by attaching or connecting the cooling <<<<
>>>>fluid tubing 23 to

0244 the device heat exchanger 5, or by simply having the cooling fluid <<<<
>>>>tubing 23 be a

0245 continuous tubular construction with device cooling fluid chamber 68 <<<<
>>>>within the device

0246 heat exchanger 5. In the preferred embodiment, as shown in FIG. 8B, <<<<
>>>>the interior of the

0247 device heat exchanger 5 is a maze of fluid baffles creating a device <<<<

>>>>cooling fluid chamber

0248 68 which is designed to lengthen the path taken by the cooling fluid <<<<

>>>>in order to maximize

0249 the heat transfer between the cooling fluid and the device heat <<<<

>>>>exchanger 5 and thus to

0250 the thermal paste 71 and the CPU 25. FIG. 8C shows the attachment of <<<<

>>>>the device heat

0251 exchanger 5 to the CPU 25 as being simply a pressed fit of the <<<<

>>>>thermal paste 71, which

0252 fills a cavity in the bottom structure of the exterior of the device <<<<

>>>>heat exchanger 5, onto

0253 the top of the CPU 25. This press fit of the thermal paste 71 onto <<<<

>>>>the CPU 25 was chosen

0254 because many currently available CPUs 25 have a heat sink structure <<<<

>>>>built onto their

0255 packaging in order to dissipate excessive heat. The thermal past 71 <<<<

>>>>will conveniently

0256 [pg,13

0257 mold itself around the heat sink structure. Additionally, a device <<<< >>>>temperature sensor 69 is

0258 shown in FIG. 8C of the preferred embodiment. The device temperature <<<< >>>>sensor 69 is in

0259 electrical communication with the controller unit 7 which uses <<<< >>>>various sensor feedbacks

0260 from the computer enclosure cooling unit 2 to control the speed of <<<< >>>>the enclosure air

0261 cooling unit blower unit 43, the speed of the pump 31, the speed of <<<< >>>>the ambient air heat

0262 exchanger blower unit 61, and the number of Peltier devices 33 which <<<< >>>>are turned on as

0263 well as the current flow through each such turned on Peltier device <<<< >>>>33. The preferred

0264 embodiment of the computer enclosure cooling unit 2 includes several <<<< >>>>sensors, air flow

0265 sensors 55, air temperature sensors 57, and a device temperature <<<< >>>>sensor 69.

0266 [P In operation, the preferred embodiment of the instant invention 2 <<<< >>>>heat is

0267 discharged from the computer enclosure cooling unit 2 and into the <<<< >>>>ambient of the room

0268 within which the computer housing 3 sits by circulating the ambient <<<< >>>>air from the room

0269 within which the computer housing 3 sits through the ambient air heat <<<< >>>>exchanger 60. By

0270 definition, the temperature of the ambient air of the room within <<<< >>>>which the computer

0271 housing 3 sits is room temperature, and a breakdown of the temperatur<<<<
>>>>e control system in
0272 the room[3 s ambient air outside the computer housing 3 is not <<<<
>>>>expected to be compensated
0273 for by the instant invention although variation of the room[3 s <<<<
>>>>ambient air temperature can
0274 be compensated for over a large range of room temperatures by the <<<<
>>>>instant invention.
0275 Typically, the ambient air in the room containing the computer <<<<
>>>>housing 3 can be expected
0276 to have a reasonable humidity, something less than one hundred <<<<
>>>>percent. Thus, the heat
0277 transfer from the computer enclosure cooling unit 2 to the ambient <<<<
>>>>air within the room
0278 will cause an expansion of the heated air and a localized decrease in <<<<
>>>>the humidity. This
0279 localized, within the ambient air heat exchanger 60, is utilized in <<<<
>>>>the instant invention to

0280 [pg,14

0281 evaporate the condensate drained into the ambient air heat exchanger <<<<
>>>>60 from the

0282 enclosure heat exchanger through the condensate drain 37. Additionall<<<<
>>>>y, the flow rate of

0283 the air circulating within the ambient air heat exchanger 60 may not <<<<
>>>>be greater than the

0284 flow rate of the air circulating within the enclosure heat exchanger <<<<
>>>>in order not to create a

0285 low pressure region at the lower end of the condensate drain 37 which <<<<
>>>>would interfere

0286 with the preferred direction of condensate flow through the <<<<
>>>>condensate drain. The hot

0287 side of the Peltier devices 33 are in heat transfer communication <<<<
>>>>with the air circulating

0288 within the ambient air heat exchanger 60. In the preferred embodiment,<<<<
>>>> this heat transfer

0289 communication is accomplished by construction of the Peltier plate 30 <<<<
>>>>in such fashion

0290 that the hot side of the Peltier devices 33 are in physical contact <<<<
>>>>with the heat conductive

0291 metal which simultaneously comprises the bottom of the Peltier plate <<<<
>>>>30 and top of the

0292 ambient air heat exchanger 60. Ambient room air circulated through <<<<
>>>>the ambient air heat

0293 exchanger 60 is thereby heated by contact with the Peltier plate[3 s <<<<
>>>>30 bottom surface

0294 which is the ambient air heat exchanger[3 s 60 upper surface. <<<<
>>>>Circulation of the air within

0295 the ambient air heat exchanger 60 is assured by the presence of the <<<<
>>>>ambient air heat

0296 exchanger blower units 61 and the arrangement of air deflection <<<<
>>>>baffles (the ambient air

0297 heat exchanger internal walls 64 of the preferred embodiment). <<<<
>>>>Greater heat exchange

0298 may be achieved by numerous other arrangements of the air deflection <<<<
>>>>baffles, but in the

0299 preferred embodiment the ambient air heat exchanger internal walls 64 <<<<
>>>>(baffles) simply

0300 form a maze, lengthening the path taken by the circulating air, by <<<<
>>>>using strips of sheet

0301 metal as the ambient air heat exchanger internal walls 64 with <<<<
>>>>apertures 65, which are

0302 stamped out of the strips, for air flow in order to decrease <<<<
>>>>construction costs.

0303 [pg,15

0304 [p The Peltier heat exchange unit 32 of the preferred embodiment <<<< >>>>comprises a Peltier

0305 plate 30 whose bottom surface is constructed of heat conductive metal <<<< >>>>to which the hot

0306 side of the Peltier devices 33 are physically mounted and a top <<<< >>>>surface constructed of

0307 heat conductive metal to which the cold side of the Peltier devices <<<< >>>>33 are physically

0308 connected. Thus the Peltier heat exchange unit 32 simply transfers <<<< >>>>heat through the

0309 Peltier devices 33 from the top surface of the Peltier heat exchange <<<< >>>>unit 32 to the bottom

0310 surface of the Peltier heat exchange unit 32. The top surface of the <<<< >>>>Peltier heat exchange

0311 unit 32 is, in the preferred embodiment constructed of a heat <<<< >>>>conductive sheet of metal

0312 which also serves as the bottom surface of the cooling fluid cooling <<<< >>>>unit 32, a liquid

0313 coolant heat exchanger. The rate of heat transfer between the top <<<< >>>>surface of the Peltier

0314 heat exchange unit 32 and the bottom surface of the Peltier plate 30 <<<< >>>>and thus of the

0315 Peltier heat exchange unit 32 is controlled by the number of Peltier <<<< >>>>devices 33 that are

0316 switched on and the current flow that is provided to each individual <<<< >>>>Peltier device 33.

0317 The preferred embodiment provides a controller unit 7 which has as <<<< >>>>inputs the outputs of

0318 the various sensors within the computer enclosure cooling unit 1 and <<<< >>>>has as outputs the

0319 current supplied to the ambient air heat exchanger blower units 61, <<<< >>>>the current supplied to

0320 the pump 31, the current supplied to the enclosure air cooling blower <<<< >>>>unit 43, as well as

0321 the current supplied to each of the Peltier devices 33. All of the <<<< >>>>inputs and outputs of the

0322 controller unit 7 are electrically connected to the various sensors <<<< >>>>and controlled devices

0323 through the ribbon cable 17. The controller unit 7 of the preferred <<<< >>>>embodiment is a

0324 computer card containing programmable circuitry with a graphical user <<<< >>>>interface

0325 permitting the computer operator to make settings for optimum <<<< >>>>computer enclosure and

0326 semiconductor device temperatures. Clearly, the controller unit 7 may <<<< >>>>be as simple as a

0327 [pg,16

0328 set of voltage and current dividers or switches preset to an average <<<<
>>>>desirable set of

0329 operating conditions or as sophisticated as circuitry driven by <<<<
>>>>artificial intelligence to

0330 continually adjust air flow rates, fluid flow rates, and the number, <<<<
>>>>identity, and current

0331 flow through individual Peltier devices 33 in order to continually <<<<
>>>>maintain optimal

0332 operating temperature for a particular semiconductor device and <<<<
>>>>ambient air temperature

0333 within the computer housing 3.

0334 [P While a single Peltier plate 30 is utilized in the preferred <<<<
>>>>embodiment, the

0335 enhanced heat transfer between sub-units of the computer enclosure <<<<
>>>>cooling unit 2 made

0336 possible by the Peltier devices 33 may be advantageously utilized <<<<
>>>>between multiple sub-units.

0337 For example a Peltier plate 30 could additionally be inserted between <<<<
>>>>the cooling

0338 fluid cooling unit 34 and the enclosure air cooling unit 26. Or, in a <<<<
>>>>slightly different

0339 configuration, the heat conductive surface which is the lower surface <<<<
>>>>of the cooling fluid

0340 cooling unit 34 in the preferred embodiment could be utilized for <<<<
>>>>both fluid cooling and

0341 air cooling by either splitting the surface between the two functions <<<<
>>>>or by interspersing

0342 the air circulation areas and the fluid circulation areas over the <<<<

>>>>single heat conductive

0343 surface. In this fashion, there would be no distinct sub-unit for the <<<<

>>>>enclosure air cooling

0344 unit 26, there would rather be a single combined enclosure air <<<<

>>>>cooling unit 26 and cooling

0345 fluid cooling unit 34. For purposes of decreasing the height and <<<<

>>>>space consumption of

0346 the computer enclosure cooling unit 2, such sharing of the heat <<<<

>>>>conductive surface which

0347 is the lower surface of the cooling fluid cooling unit 34 may be <<<<

>>>>advantageous. Such

0348 utilization of multiple Peltier plates 30 or of shared heat exchange <<<<

>>>>surfaces do not depart

0349 from the teachings of the preferred embodiment.

0350 [pg,17

0351 [p The fluid heat exchanger (the cooling fluid cooling unit 34 of the <<<<
>>>>preferred

0352 embodiment) is comprised of heat conductive tubing in physical <<<<
>>>>contact with a floor

0353 which is the heat conductive sheet metal comprising the upper surface <<<<
>>>>of the Peltier heat

0354 exchange unit 32 and with a ceiling which is the lower surface of the <<<<
>>>>heat conductive

0355 sheet metal comprising the lower surface of the enclosure air cooling <<<<
>>>>unit 26. Thus fluid

0356 cooling takes place by heat exchange from the cooling fluid to the <<<<
>>>>heat conductive tubing

0357 (the cooling fluid chamber 35 of the preferred embodiment) in which <<<<
>>>>the cooling fluid is

0358 contained, from the heat conductive tubing to the heat conductive <<<<
>>>>sheet metal comprising

0359 the lower surface of the cooling fluid cooling unit 34, from the heat <<<<
>>>>conductive lower

0360 surface of the cooling fluid cooling unit 34 to the cold side of the <<<<
>>>>Peltier devices 33 that

0361 are in physical contact with the underside of the heat conductive <<<<
>>>>sheet metal that is the

0362 lower surface of the cooling fluid cooling unit 34, across the <<<<
>>>>Peltier devices 33 from the

0363 cold side to the hot side, from the hot side of the Peltier devices <<<<
>>>>33 to the lower surface of

0364 the Peltier plate 30, from the upper side of the heat conductive <<<<
>>>>metal comprising the

0365 lower surface of the Peltier plate 30 to the air circulating within <<<<
>>>>the ambient air heat

0366 exchanger 60, and from thence is exhausted out through the ambient <<<<
>>>>air heat exchanger

0367 air exhaust 21 out into the ambient of the room containing the <<<<
>>>>computer housing 3. The

0368 cooling fluid flow direction within the device heat exchanger 5 is <<<<
>>>>shown in FIG. 8B by

0369 device cooling fluid flow arrows 67 thus the direction of fluid flow <<<<
>>>>within the cooling

0370 fluid tubing 23 is defined. As seen in FIG. 3, the cooling fluid <<<<
>>>>flows out of the cooling

0371 fluid cooling unit 34 of the computer enclosure cooling unit 2 <<<<
>>>>through the cooling fluid

0372 tubing 23 and is circulated through a device cooling fluid chamber 68 <<<<
>>>>(shown in FIG. 8)

0373 which is in heat exchange communication with a semiconductor device, <<<<
>>>>in the preferred

0374 [pg,18

0375 embodiment a single CPU 25. There may be, by obvious modification of <<<<
>>>>the cooling

0376 fluid tubing 23, a plurality of the device heat exchangers 5 cooling <<<<
>>>>a plurality of

0377 semiconductor devices. The device heat exchanger 5 of the preferred <<<<
>>>>embodiment is

0378 simply a fluid flow maze whose baffles and walls are constructed of <<<<
>>>>heat conductive

0379 material. Numerous baffle configurations may be utilized to optimize <<<<
>>>>turbulence and/or

0380 lengthen the effective fluid flow path in order to optimize heat <<<<
>>>>transfer between the

0381 cooling fluid and the heat conductive walls and baffles which form <<<<
>>>>the device cooling

0382 fluid chamber 68 of the device heat exchanger 5. The device heat <<<<
>>>>exchanger 5 is in heat

0383 exchange communication with the semiconductor device to be cooled or <<<<
>>>>temperature

0384 controlled. The preferred embodiment monitors the temperature of the <<<<
>>>>semiconductor

0385 device being cooled with the device temperature sensor 69 and <<<<
>>>>utilizes thermal paste 71

0386 to both affix the device heat exchanger 5 to the semiconductor device <<<<
>>>>(CPU 25 in the

0387 preferred embodiment) being cooled and enhance heat transfer between the

0388 semiconductor device being cooled and the cooling fluid being <<<<
>>>>circulated through the

0389 cooling fluid tubing 23 and the device cooling fluid chamber 68 <<<<

>>>>within the device heat

0390 exchanger 5. Further, the thermal paste 71 serves to both put the <<<<
>>>>device temperature

0391 sensor 71 in heat flow communication with the semiconductor device <<<<
>>>>being cooled and to

0392 affix the device temperature sensor 71 to the device heat exchanger 5.

0393 [P Heat flow communication between the cooling fluid within the <<<<
>>>>cooling fluid

0394 cooling unit 34 and the heat conductive material comprising the lower <<<<
>>>>surface of the

0395 enclosure air cooling unit 26 acts to provide a cool surface for heat <<<<
>>>>exchange with the air

0396 circulating within the enclosure air cooling unit 26. The preferred <<<<
>>>>embodiment, created

0397 with cost considerations foremost in mind, utilizes simple heat <<<<
>>>>conductive sheet metal for

0398 [pg,19

0399 the surfaces between the enclosure air cooling unit 26 and the <<<<
>>>>cooling fluid cooling unit

0400 34, between the cooling fluid cooling unit 34 and the Peltier plate <<<<
>>>>30, between the Peltier

0401 plate 30 and the ambient air heat exchanger 60, and for the <<<<
>>>>construction of the computer

0402 enclosure cooling unit housing 1 which serves as the outer walls of <<<<
>>>>all sub-units as well

0403 as the upper surface of the enclosure air cooling unit 26 and the <<<<
>>>>lower surface of the

0404 ambient air heat exchanger 60. This construction of the computer <<<<
>>>>enclosure cooling unit

0405 housing 1 from heat conductive sheet metal is consistent with current <<<<
>>>>standardized size,

0406 shape and materials for peripherals intended to be installed, as the <<<<
>>>>preferred embodiment

0407 is, in a [b 5.25 [l inch drive bay 11; but is non-optimal as the heat <<<<
>>>>conductive sheet metal

0408 provides heat flow communication in a negative feedback loop around <<<<
>>>>the various sub-units

0409 of the computer enclosure cooling unit 2 and thereby creates substantial

0410 inefficiencies. A second embodiment of the instant invention provides <<<<
>>>>that the computer

0411 enclosure cooling unit housing 1 be constructed of non-heat <<<<
>>>>conductive materials while

0412 maintaining the use of heat conductive material for the surfaces <<<<
>>>>between the enclosure air

0413 cooling unit 26 and the cooling fluid cooling unit 34, between the <<<<

>>>>cooling fluid cooling

0414 unit 34 and the Peltier plate 30, between the Peltier plate 30 and <<<<
>>>>the ambient air heat

0415 exchanger 60.

0416 [P The enclosure air cooling unit 26 of the preferred embodiment <<<<
>>>>provides a

0417 minimum of air baffles for heat exchange to the air circulating <<<<
>>>>within it. This

0418 construction has been found to be adequate to provide modest cooling <<<<
>>>>of the interior of

0419 the computer housing 3. Current art for the cooling of the interior <<<<
>>>>of computer housings

0420 3 depends on air leakage into the enclosure formed by the computer <<<<
>>>>housing 3 and fans to

0421 exhaust that air which is leaking in. Some prior art specifically <<<<
>>>>provides for air flow into

0422 [pg,20

0423 the enclosure formed by the computer housing 3 from the ambient in <<<<
>>>>the room enclosing

0424 the computer housing 3. However, enhanced cooling of the interior of <<<<
>>>>the computer

0425 housing 3 can be achieved by increasing the turbulence of the air and <<<<
>>>>increasing the

0426 number and complexity of arrangement of the air baffles within the <<<<
>>>>enclosure air cooling

0427 unit 26. Enhanced cooling of the air exhaust into the interior of the <<<<
>>>>computer housing 3

0428 from the enclosure air cooling unit 26 raises the possibility of <<<<
>>>>condensate forming within

0429 the interior of the computer housing 3 and thereby creating shorts <<<<
>>>>around the various

0430 electrical and electronic components therein. Such possibility of <<<<
>>>>condensate forming is

0431 created by the interaction of the cool, partially dried, air exhaust <<<<
>>>>into the interior of the

0432 computer housing 3 from the air exhaust 29 of the enclosure air <<<<
>>>>cooling unit 26 with the

0433 relatively moist air leaking into the interior of the computer <<<<
>>>>housing 3 from the ambient

0434 in the room containing the computer housing 3. This possibility of <<<<
>>>>condensate formation

0435 within the interior of the computer housing 3 can be substantially <<<<
>>>>eliminated through the

0436 use of positive air pressure within the interior of the computer <<<<
>>>>housing 3. Positive air

0437 pressure would force air leakage out of the interior of the computer <<<< >>>>housing 3, thereby

0438 eliminating the source of humidity in the air interior to the <<<< >>>>computer housing 3. Positive

0439 air pressure can be achieved by moving the air input to the enclosure <<<< >>>>air cooling unit 26

0440 such that it permits air intake from the ambient air in the room <<<< >>>>containing the computer

0441 enclosure rather than from the interior of the computer housing 3. <<<< >>>>Accordingly, a third

0442 embodiment of the instant invention provides for the enclosure air <<<< >>>>cooling unit air intake

0443 27 to be located such that air is input to the enclosure air cooling <<<< >>>>unit 26 from the

0444 ambient air in the room containing the computer housing 3 and not <<<< >>>>from the interior of

0445 the computer housing 3. In the third embodiment, it is necessary that <<<< >>>>the local air

0446 [pg,21

0447 circulation paths created within the ambient air of the room <<<<
>>>>containing the computer

0448 housing 3 by the air intake to the enclosure air cooling unit 26 on <<<<
>>>>the one hand and the air

0449 exhaust from the ambient air heat exchanger 60 on the other hand be <<<<
>>>>kept apart and

0450 distinct.

0451 [P Cooling of the air within the enclosure air cooling unit 26, <<<<
>>>>whether configured as

0452 in the preferred embodiment or in the third embodiment, creates a <<<<
>>>>condensate on the

0453 cooled surface(s) where the heat exchange with the circulating air <<<<
>>>>takes place. In the

0454 preferred embodiment the lower surface of the enclosure air cooling <<<<
>>>>unit 26 is beveled or

0455 sloped toward a condensate drain 37. The condensate drain 37 <<<<
>>>>comprises a tube having

0456 its upper end opening in the lower surface of the enclosure air <<<<
>>>>cooling unit 26 and its

0457 lower end opening in the upper surface of the ambient air heat <<<<
>>>>exchanger 60. The

0458 condensate drain 37 is ideally comprised of non-heat conductive <<<<
>>>>materials, alternatively,

0459 the condensate drain 37 may be heat insulated from the heat <<<<
>>>>conductive surfaces that it

0460 passes through. Freezing of the condensate within the tube comprising <<<<
>>>>the condensate

0461 drain 37 as it passes through the upper surface of the Peltier plate <<<<

>>>>30 must be avoided. A

0462 yet third, and not as desirable, solution to avoid condensate <<<<

>>>>freezing is to make the tubing

0463 comprising the condensate drain 37 highly heat conductive such that <<<<

>>>>efficiency of the

0464 Peltier plate 30 is sacrificed in the vicinity of the condensate <<<<

>>>>drain[3 s 37 passage through

0465 the upper surface of the Peltier plate 30 by heat feedback from the <<<<

>>>>lower surface of the

0466 Peltier plate 30.

0467 [P A fourth embodiment of the instant invention provides that the air <<<<

>>>>exhaust from

0468 the computer housing 3, having been cooled by the air exhaust from <<<<

>>>>the enclosure air

0469 cooling unit air exhaust 29, is input to the ambient air heat <<<<

>>>>exchanger air intake 19. Thus

0470 [pg,22

0471 a single path for air flow from and to the ambient air within the <<<<
>>>>room containing the

0472 computer housing 3 is established. Greater efficiency of heat <<<<
>>>>exchange over the entirety

0473 of the computer enclosure cooling unit 2 can be achieved by the <<<<
>>>>fourth embodiment, but

0474 at a cost of increased tubing or piping to contain the flow of air <<<<
>>>>from the air exhaust of

0475 the enclosure air cooling unit 26 to the ambient air heat exchanger <<<<
>>>>air intake 19.

0476 [P A yet fifth embodiment of the instant invention provides that both <<<<
>>>>the air exhaust

0477 from the computer housing 3 is input to the ambient air heat <<<<
>>>>exchanger air intake 19 and

0478 that the air intake to the enclosure air cooling unit 26 be <<<<
>>>>positioned to permit air intake

0479 from the ambient air in the room containing the computer housing 3 <<<<
>>>>and not from the

0480 interior of the computer housing 3. The fifth embodiment, in <<<<
>>>>combination with the

0481 above-described possible enhancements to the air baffle configuration <<<<
>>>>of the enclosure air

0482 cooling unit 26 provides a superior computer enclosure cooling unit 2,<<<<
>>>> albeit at greater

0483 cost.

0484 [p While the preferred embodiments of the instant invention have been <<<<
>>>>described in

0485 substantial detail and fully and completely hereinabove, it will be <<<<

>>>>apparent to one skilled

0486 in the art that numerous variations of the instant invention may be <<<<

>>>>made without

0487 departing from the spirit and scope of the instant invention, and <<<<

>>>>accordingly the instant

0488 invention is to be limited only by the following claims.

0489 [pg,23

0490 [cl DESCRIPTION OF NUMERIC REFERENCES

0491 [p0 1. Computer Enclosure Cooling Unit Housing

0492 [p0 2. Computer Enclosure Cooling Unit

0493 [p0 3. Computer Housing

0494 [p0 5. CPU Cooler

0495 [p0 9. Motherboard

0496 [p0 7. Controller Unit

0497 [p0 11. [b 5.25[1 [40 [0 Drive Bays

0498 [p0 13. [b 3.5[1 [41 [0 Drive Bay

0499 [p0 15. Mounting Holes

0500 [p0 17. Ribbon Cable

0501 [p0 19. Ambient Air Heat Exchanger Air Intake (Air Intake)

0502 [p0 21. Ambient Air Heat Exchanger Air Exhaust (Air Exhaust)

0503 [p0 23. Cooling Fluid Tubing

0504 [p0 25. CPU

0505 [p0 26. Enclosure Air Cooling Unit

0506 [p0 27. Enclosure Air Cooling Unit Air Intake

0507 [p0 29. Enclosure Air Cooling Unit Air Exhaust

0508 [p0 30. Peltier Plate

0509 [p0 31. Pump

0510 [p0 32. Peltier Heat Exchange Unit

0511 [p0 33. Peltier Device

0512 [p0 34. Cooling Fluid Cooling Unit

0513 [p0 35. Device Heat Exchanger

0514 [p0 37. Condensate Drain

0515 [p0 39. Ambient Air Heat Exchanger Air Flow Chamber

0516 [p0 43. Enclosure Air Cooling Unit Blower Unit

0517 [p0 45. Enclosure Air Cooling Unit Air Flow Baffles

0518 [p0 47. Enclosure Air Cooling Unit Air Flow Arrows

0519 [p0 49. Condensate Drain Flow Arrows

0520 [p0 51. I[41 [0 Ledge Created by Extended Lower Level

0521 [p0 53. Pettier Wiring

0522 [p0 55. Air Flow Sensor

0523 [p0 57. Air Temp Sensor

0524 [p0 59. Ambient Air Heat Exchanger Air Flow Arrows

0525 [p0 60. Ambient Air Heat Exchanger

0526 [p0 61. Ambient Air Heat Exchanger Blower Unit

0527 [p0 63. Ambient Air Heat Exchanger Blower Unit Wiring

0528 [p0 64. Ambient Air Heat Exchanger Internal Walls

0529 [p0 65. Apertures in Ambient Air Heat Exchanger Internal Walls

0530 [p0 67. Device Cooling Fluid Flow Arrows

0531 [p0 68. Device Cooling Fluid Chamber

0532 [p0 69. Device Temperature Sensor

0533 [p0 71. Thermal Paste

0534 [pg,24

0535 +cm What is claimed is:

+PG,25

0536 +cm 1. An enclosure cooling unit which comprises

0537 [p1 a first heat exchanger,

0538 [p1 a second heat exchanger,

0539 [p1 a third heat exchanger, and

0540 [p1 one or more Peltier devices;

0541 [ps wherein

0542 [p1 said first heat exchanger transfers heat from said enclosure <<<<
>>>>cooling unit to the

0543 ambient air outside said enclosure,

0544 [p1 said second heat exchanger transfers heat from the air within <<<<
>>>>said enclosure to

0545 said enclosure cooling unit,

0546 [p1 said third heat exchanger transfers heat from cooling fluid <<<<
>>>>circulating within

0547 said enclosure to said ambient air,

0548 [p1 said one or more Peltier devices transfer heat from said second <<<<
>>>>heat exchanger to

0549 said first heat exchanger, and

0550 [p1 said one or more Peltier devices transfer heat from said second <<<<
>>>>heat exchanger to

0551 said third heat exchanger.

0552 +cm 2. The invention of claim 1 additionally comprising one or more <<<<
>>>>additional heat

0553 exchangers

0554 [p1 Wherein said enclosure additionally contains one or more heat <<<<
>>>>producing

0555 components, and

0556 [p1 Wherein each of said additional heat exchangers transfers heat <<<<

>>>>from one or more Δ OF 1

0557 [pg, 25 26

0558 of said heat producing components to said cooling fluid. 1

0559 +cm 3. The invention of claim 1 additionally comprising a controller <<<<
>>>>unit and sensors

0560 [p1 wherein said sensors detect various temperature and flow rates <<<<
>>>>within said

0561 enclosure cooling unit,

0562 [p1 said sensors provide information regarding said detected <<<<
>>>>temperature and flow rates

0563 to said controller,

0564 [p1 said controller provides voltages and currents to electrical <<<<
>>>>and/or electronic

0565 components within said enclosure cooling unit, and

0566 [p1 said controller utilizes said detected temperature and flow rates <<<<
>>>>to determine said

0567 voltages and currents.

STET ~~2 INS — CLAIMS 4,7,5~~ NO ERRORS

0568 +cm 4 6. An enclosure cooling unit comprising ← 1

0569 [p1 a first heat exchanger,

0570 [p1 a second heat exchanger,

0571 [p1 a third heat exchanger, and

0572 [p1 one or more Peltier devices;

0573 [ps wherein

0574 [p1 said first heat exchanger transfers heat from said enclosure <<<<
>>>>cooling unit to the

0575 ambient air outside said enclosure,

0576 [p1 said second heat exchanger transfers heat from the air within <<<<
>>>>said enclosure to

0577 said enclosure cooling unit,

0578 [p1 said third heat exchanger transfers heat from cooling fluid <<<<

>>>>circulating within said

0579 enclosure to said enclosure cooling unit, and

0580 [p1 said one or more Peltier devices transfer heat from said second <<<<

>>>>heat exchanger to

0581 [pg, 26 27

0582 said first heat exchanger.

0583 +cm 5. The invention of claim 4 additionally comprising one or more <<<<

>>>>additional heat

0584 exchangers

0585 [p1 wherein said enclosure additionally contains one or more heat <<<<

>>>>producing

0586 components, and

0587 [p1 wherein each of said additional heat exchangers transfers heat <<<<

>>>>from one or more of

0588 said heat producing components to said cooling fluid.

0589 +cm 26. The invention of claim 4 additionally comprising a controller <<<<

>>>>unit and sensors

0590 [p1 wherein said sensors detect various temperature and flow rates <<<<

>>>>within said

0591 enclosure cooling unit,

0592 [p1 said sensors provide information regarding said detected <<<<

>>>>temperature and flow

0593 rates to said controller,

0594 [p1 said controller provides voltages and currents to electrical <<<<

>>>>and/or electronic

0595 components within said enclosure cooling unit, and

0596 [p1 said controller utilizes said detected temperature and flow rates <<<<

>>>>to determine said

0597 voltages and currents.

0598 [cm 7. An enclosure cooling unit comprising

0599 [p1 a first heat exchanger,

0600 [p1 a second heat exchanger,

0601 [p1 a third heat exchanger, and

0602 [p1 one or more Peltier devices;

0603 [ps wherein

0604 [p1 said first heat exchanger transfers heat from said enclosure <<<<

>>>>cooling unit to the

0605 [pg, 27

0606 ambient air outside said enclosure,

0607 [p1 said second heat exchanger transfers heat from cooling fluid <<<<
>>>>circulating within

0608 said enclosure to said enclosure cooling unit,

0609 [p1 said third heat exchanger transfers heat from the air within said <<<<
>>>>enclosure to

0610 said cooling fluid, and

0611 [p1 said one or more Peltier devices transfer heat from said second <<<<
>>>>heat exchanger to

0612 said first heat exchanger.

0613 +cm 8. The invention of claim 7 additionally comprising one or more <<<<
>>>>additional heat

0614 exchangers

0615 [p1 wherein said enclosure additionally contains one or more heat <<<<
>>>>producing

0616 components, and

0617 [p1 wherein each of said additional heat exchangers transfers heat <<<<
>>>>from one or more of

0618 said heat producing components to said cooling fluid.

0619 +cm 9. The invention of claim 7 additionally comprising a controller <<<<
>>>>unit and sensors

0620 [p1 wherein said sensors detect various temperature and flow rates <<<<
>>>>within said

0621 enclosure cooling unit,

0622 [p1 said sensors provide information regarding said detected <<<<
>>>>temperature and flow rates

0623 to said controller,

0624 [p1 said controller provides voltages and currents to electrical <<<<

>>>>and/or electronic

0625 components within said enclosure cooling unit, and

0626 [p1 said controller utilizes said detected temperature and flow rates <<<<

>>>>to determine said

0627 voltages and currents.

0628 +cm 10. The invention of claim 7 wherein

0629 [pg, ~~28~~ 29

0630 [p1 said one or more Peltier devices transfer heat from said third <<<<
>>>>heat exchanger to

0631 said second heat exchanger.

0632 +cm 11. The invention of claim 7 wherein

0633 [p1 said one or more Peltier devices transfer heat from said third <<<<
>>>>heat exchanger to said

0634 first heat exchanger.